Multimedia in Higher Education: Three Years of Experience with e-Learning for Civil Engineering

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Abstract

The main course at the Institute of Structural Concrete of Graz University of Technology has been supported by the e-Learning project *interactive Visualizations in Civil Engineering*, short iVISiCE (Ebner and Holzinger, 2002) for three years now. A large number of animations, visualizations and so called Interactive Learning Objects (ILO) have been created. By using the e-learning platform eLS (eLS, 2003) based on Hyperwave (Maurer, 1996) a **blended learning scenario** has been applied. The use of discussion forums, chats and e-Mails leads to a new way of teaching. In this paper we provide an overview of some of our experiences and results of the last three years; some didactical concepts and we propose the potential and possibilities of e-Learning in Higher education, but also the problems of such applications, are proposed.

1 Introduction

e-Learning and Higher Education – two catchwords of the "new generation". How can universities investigate the possibilities of Internet use in Higher Education? Leads the use of these methods to a so called life-long learning? Is the adoption of multimedia content a promise for the future of teaching and learning?

Figure 1: The logo of the project iVISiCE

All these questions must be answered within the next years; and in fact, in order to find answers for these questions a lot of studies have been say instigated at Universities all over the world.

2 Theoretical Background

At first we must note that Multimedia *cannot* improve per se the learning of the individual. Learning is a basic **cognitive process,** which has to be done by the learners themselves (Wilson et al., 1974), (Hall, 1988), (Solso, 1995). As a matter of fact, the Nuremberg funnel, in which knowledge is poured into the heads of the students, does not exist (Carroll, 1990) - even in the 21st century! But by using Multimedia for learning purposes, teachers as well as learners have new possibilities. However, a big potential chance of multimedial learning is increasing the motivation and interaction (Holzinger and Maurer, 1999). By increasing motivation and enhancing interaction you hold the students attention longer on the material, triggering thinking (self-thinking of the students) and consequently get better learning results (Holzinger, 1997). But Education is also a **social process**; people interacting with people; the teacher interacting with the learners; learners interacting with the teacher and just as important, the learner interacting with other learners (Lee Price and Lapham, 2003) – and for some years there is a new way of interaction: computer - learner. Learning is an active process on the part of the learner but also a social process and proceeds through conversation (Dewey, 1916), (Holzinger, 2002). The current university education does little to assist the students during their learning process. We are of the opinion that a Student-centered teaching (Motschnig and Holzinger, 2002) becomes more and more important.

A clear definition of "multimedia" as such has proven a problem ever since this word was coined, but the original definition of multimedia was in the context of computer systems with the capacity to deliver visual and audio information – *interactively* (Gonzalez, 2000). It is exactly this **interactivity** which is a necessary and fundamental mechanism for knowledge acquisition and learning (Sims, 1997).

Using multimedia over the Web enables teachers to use interesting aspects of interactivity, e.g. interaction over almost unlimited distances is possible. This is of course essential in rural areas - or for worldwide collaboration. Enormous increase in the ability to access multimedia information has resulted from the convergence in the past few years of several complementary factors:

1) powerful computers have become cheap enough to be available at any place;
2) the Web, as part of the Internet, has become an enormous ubiquitous open learning space consisting of interconnected, global computer networks; and
3) the development of user friendly Web browsers which provide access to multimedia Web pages in universally accepted formats.
It is apparent that lecturers are now just beginning to understand the current and future potential of this new Web technology for university courses, particularly in the areas of course-material distribution, course-material enhancement via hyperlinks to related Websites, multimedia lecture enhancement, electronic notes and books, and interactive learning (McIntyre and Wolff, 1998). The importance of multimedia learning is especially high in fields such as Medicine (Filler et al., 2000).

3 The lecture structural concrete online – iVISiCE

Since November 2001 the lecture course structural concrete has been supported by the e-Learning project called iVISiCE (Logo see Figure 1).
With the aid of the web-based course management system Hyperwave eLS a **blended learning scenario** has been applied.
The lecture course (Sparowitz, 2001) is a required subject for the study of civil engineering and takes place in the 7th semester in the curriculum, lasting about four months. The basic content is the design and the construction of reinforced or pre-stressed concrete structures by using the European Standard Norm (Figure 2).
Because of the complex coherences it is very difficult to describe the engineering models and the physically relationships. And so the project iVISiCE tries to make the content approachable by the audience by using methods of visualization.

Figure 2: Reinforcement of a typically structural concrete beam

The project, which was founded in November 2002, should investigate the lecture which the possibilities of the Internet. The aim of the whole development is to help the learners by making the material more understandable. After three years of field-testing three topics seem to be the crucial ones: interaction, communication and visualization. With the help of an e-Learning platform this topics have been implemented. The course-management system has been provided by the computer department of the University since November 2001.
An overview of all measures are shown in Figure 3. In the following chapters we will describe the content of each part more in detail.

3.1 Basic content

In November 2001 the first measure was embedding the basic content of the lecture. It compromises all supporting documents and hand outs (Freytag et al., 2001). The students can download and print all scripts for free. Further some MS Power Point-presentations have been made available within the course-management system. In the end an engineering software completed the basic content. This components are absolutely necessary in an e-Learning environment. In Figure 3 it is summarized in the yellow circle. The advantage of this kind of distribution was the diminishment of the administration.

3.2 Communication

The possibility to bring teachers and students more in touch and the promotion of student-student as well as student-teacher dialogues seem to us to be a great promise of e-Learning in Higher education and is in accordance with (Lee Price and Lapham, 2003). The Computer-mediated-Communication (CMC) happened *asynchronous* (e-mail, discussion forum or virtual blackboard) or *synchronous* (via chat or virtual office hour). (Dimai and Ebner, 2003) could show, that the rate of attendance is very high, although the decision of participation is not obligated. The use of online communication tools is necessary to give deeper information. Only then the expression A^3 (anytime, anywhere and anybody) can be used for e-Learning.

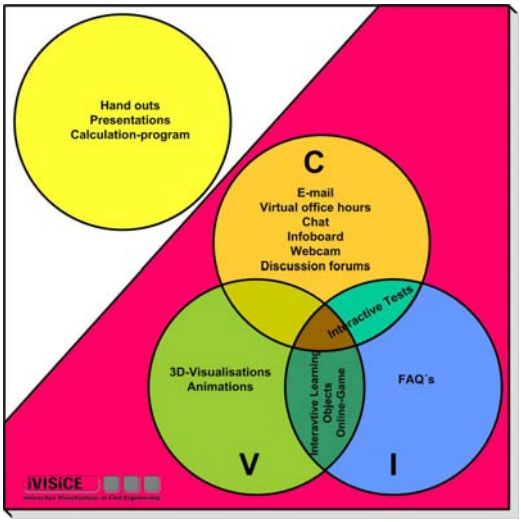

Figure 3: The content of the project: communication is a core factor

During the lecture several discussion forums for each main topic of the lecture have been founded. To support the learning process in real-time about 2 virtual office hours, chats at a fixed time, per week have been held. It must be pointed out, that the active participation of the students is about 30%.

Further an Infoboard was installed. This means a kind of virtual notice-board. There all urgent messages concerning the lecture have been posted. “Standing in front of an empty lecturing room – a thing of the past” (Student – from personal essay) – describes the great success of this measure. Updating the board keeps the students to bear in mind about the latest information.

In the second run (November 2002) a webcam was installed for the transport of pictures via the web, because sometimes an explanation without a sketch seems hopelessly. For the upload of the pictures a free software was used and with an automatically refresh of a html-page the students could view the drawing. A very cheap but often essential method to explain a complex problem.

Newcomers to the Net often use e-Mail and wouldn`t dream of posting because they feel don’t understand the rituals and the new kind of diction (Preece et al., 2002). To solve this problem an anonymous user was installed to give the possibility of anonym online communication.

Of course during the project e-Mail was used, but we tried to use it only for private motives. It would not be possible to answer all the bunch of e-mails from the students. For problems concerning the lecture the students have to post it in the discussion forums and then they get *there* the answers - consequently everybody else can read it.

3.3 Visualization

The first steps during the development of the project was the creation of a number of animations (Figure 4). The advantage of animations in relation to static visuals are the capability of demonstrating movements and trajectories (Weiss et al., 2002). In explaining how the reinforcement of a concrete beam works, an instructor is most likely to rely on printed or spoken word. But it is much easier to explain the same problem with an animation and it is also more understandable for the students. The goal is to improve the understanding of engineering problems by animating essential topics. In the first year of the project about twenty animation has been created with Macromedia Flash (Holzinger and Ebner, 2003). By using the vector based technology the development of very small files was possible. The animations are be explained by the professor during the lecture and then they are published in the course-management system for the students. The learners need only a browser and the free flash plugin. In the future the animations set to music, because then the explanation can listened by the students once more. One prototype has been used this year. Further two three-dimensional visualizations have been implemented. The aim is to explain the detailing of complex reinforcements, because often it is very hard to illustrate a three-dimensional reinforcement with the help of a two-dimensional sketch. The visualizations were produced with VRML, the students need only the free browser plug-in.

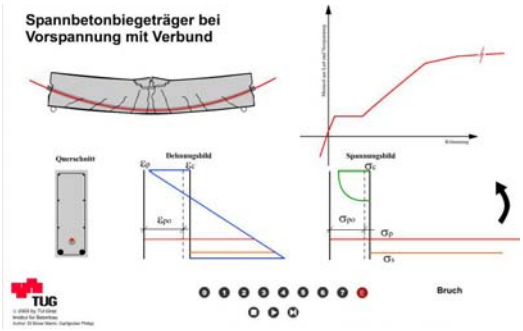

Figure 4: Animation

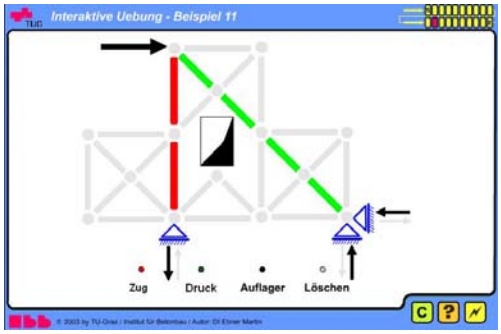

Figure 5: Interactive Learning Object

3.4 Interaction

Having in mind, that the learning process can be activated by doing (interaction!), we decided to take further steps from animations towards Interaction. Because the visualizations are comparable with a video film. The students watch them, but they don't learn. And so as third part of the project Interactive Learning Objects have been created (Ebner and Holzinger, 2003). These required the students to operate the visualizations interactively by themselves. The output of the interactive animation is dependent of the user-input. So learning in real-time becomes possible.

Technologically the interactive exercises have also been programmed with Macromedia Flash. All ILOs consists of following major parts (Figure 5): First the presentation of learning information (advanced organizer), the core learning material and a careful selected problem. According to (Gagne, 1965), (Gagne and Briggs, 1979) who describes some good principles of learning and instructional design, the students have to know all these elements for a **structural learning process.** The second part consists of communication – between computer – learner (help information) or between teacher – learner via specific discussion forums. The third part of the ILO is a multiple choice test, where the major facts have been proved and repeated once more.
Further interactive tests have been installed. With this virtual examination students can exercise themselves. This examples go conform with the real written test. Additionally a one way board was created, where the learners can leave their problems as messages for all the other learners. This tool is very popular amongst our students. The next measure was the installation of a special form of FAQ´s. First the teacher and the tutor collected the frequently asked questions. After that each topic was answered by the teachers and implemented in a multiple choice test. The aim of this measure was that first the learner read the problem and also the right answer. After that he/she can prove him/herself by answering a short test question. Only then the right understanding will be guaranteed.
The recent development is the Online-Game (Figure 6) "*Schnittkrafteuropameisterschaft*". With the help of this game the learners should exercise themselves in recognition of right static internal forces. The evaluation and the scientific analysis is under way.

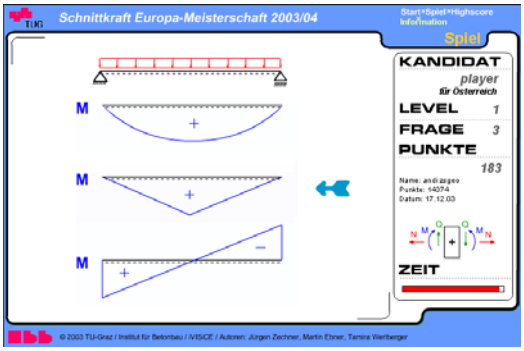

Figure 6: The Online-Game

4 Findings, discussion and conclusion

A lot of research, experiments and evaluations during the last three years lead to the following major points, which seem to be absolutely necessary for successful e-Learning:

- A wide range of tools for online communication: One of our evaluation shows that students who use for example the discussion forums don´t use the possibility of chats and vice versa. They either participated on the virtual office hour or posted a contribution. This phenomenon goes back to the different behaviour of each learner. As fact we can mentioned that it is absolutely necessary for development of e-Learning surroundings to support a wide range of tools. Even a step forward we have to point out that personalized tools will be a crucial factor for the future.

- "Support around the clock" seems to be necessary. The problems of the students should be solved within short time, because only then the A^3 phrase will work. However, the effort of the teachers increases considerably!
- Animations can clarify abstract relationships, that might otherwise be difficult to understand and learn (Holzinger & Ebner, 2003). Often it is not possible to explain complex things with a few words - but a simulation can easily display complex models.
- "Learning by doing" leads to a more in depth-learning. With the help of animations and visualizations the explanation of complex engineering models is much easier, but this does not lead automatically to a better learning success. As we show in Ebner & Holzinger (2003) learning an active process on the part of the learner, where knowledge and understanding is constructed by the learner. Only the transmitting of information from someone who knows to someone who does not leads not to a learning process.
- We must bear in mind, that an ILO must attend to only one problem. Because students are not comparable with experts and learn the material step for step. In our first developments the exercises were to complex and to difficult. This leads to a very poor participation. Further usability tests show us that a good description of the learning material and a clear task are crucial factors for successful e-Learning.
- The A^3 phrase will also only work, if the online-distribution goes smoothly. Small files, timely uploads, uncomplicated installation and stability of the system are necessary requirements for e-Learning, because the students like to learn something about the lecture and not to administrate their computers. A very fast support guaranteed user-satisfaction, this means also a additionally burden for the teachers or administrators.

We can summarize that e-Learning has a great potential for the future. Especially the **mix** of (real) lectures together with the online material proved to be successful. However, the learner must be always in the focus of our research.

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